U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB-277 360

Fish Lake
Sevier County, Utah

National Eutrophication Survey, Corvallis, Oreg

Prepared for

Corvallis Environmental Research Lab, Oreg

Oct 77

PB 277 360

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT
ON
FISH LAKE
SEVIER COUNTY
UTAH
EPA REGION VIII
WORKING PAPER No. 839

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

☆G.P.O. 699-440

REPORT
ON
FISH LAKE
SEVIER COUNTY
UTAH
EPA REGION VIII
WORKING PAPER No. 839

WITH THE COOPERATION OF THE
UTAH STATE DIVISION OF HEALTH
AND THE
UTAH NATIONAL GUARD
OCTOBER, 1977

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO. PB277360
4. TITLE AND SUBTITLE Report on Fish Lake, Sevier County, Utah		5. REPORT DATE Prepared October 1977 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)		8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 839
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Eutrophication Survey U.S. Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460		13. TYPE OF REPORT AND PERIOD COVERED Final - 1975 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		48G

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
Release unlimited		40
	20. SECURITY CLASS (This page)	22. PRICE PC A03/MF A01

EPA Form 2220-1 (9-73)

CONTENTS

	Page
Foreward	ii
List of Utah Study Lakes and Reservoirs	iv
Lake and Drainage Area Map	v
Sections	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	3
III. Lake Water Quality Summary	5
IV. Nutrient Loadings	8
V. Literature Reviewed	12
VI. Appendices	13

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Utah Department of Social Services and the Utah Department of Natural Resources for professional involvement, to the Utah National Guard for conducting the tributary sampling phase of the Survey, and to those Utah wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staffs of the Bureau of Water Quality of the Division of Health and the Division of Wildlife Resources provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

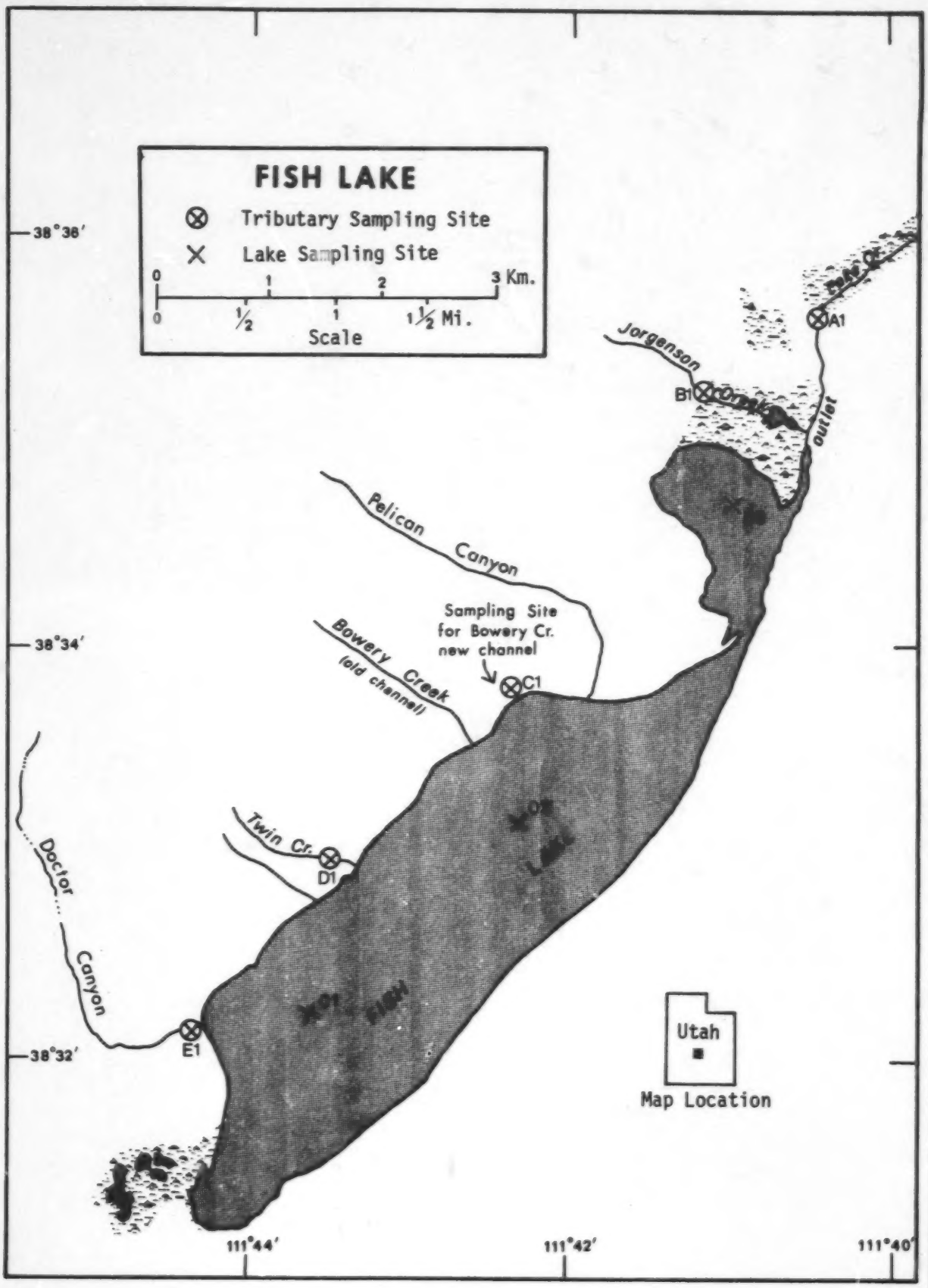
Major General Maurice L. Watts, the Adjutant General of Utah, and Project Officer Lt. Colonel T. Ray Kingston, who directed the volunteer efforts of the Utah National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES AND RESERVOIRS

STATE OF UTAH

NAME	COUNTY
Bear	Rich, UT; Bear Lake, ID
Deer Creek	Wasatch
Echo	Summit
Fish	Sevier
Flaming Gorge	Daggett, UT; Sweetwater, WY
Huntington	Emery
Joes Valley	Emery
Lower Bowns	Garfield
Lynn	Box Elder
Minersville	Beaver
Moon	Duchesne
Navajo	Kane
Newcastle	Iron
Otter Creek	Piute
Panguich	Garfield
Pelican	Uintah
Pineview	Weber
Piute	Piute
Porcupine	Cache
Powell	Garfield, Kane, San Juan, UT; Coconino, AZ
Pruess	Millard
Sevier Bridge	Juab, Sanpete
Starvation	Duchesne
Steinaker	Uintah
Tropic	Garfield
Utah	Utah
Willard Bay	Box Elder


FISH LAKE
Tributary Sampling Site
Lake Sampling Site
0 1 2 3 Km.
0 ½ 1 1½ Mi.
Scale
38°36'
38°34'
38°32'
111°44'
111°42'
111°40'
A1
B1
Jorgenson
outlet
Pelican Canyon
Sampling Site for Bowery Cr. new channel
C1
Bowery Creek (old channel)
Twin Cr.
D1
Doctor Canyon
E1
Fish Lake
Utah
Map Location

FISH LAKE

STORET NO. 4906

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that the main body of Fish Lake is mesotrophic but shallow Widgeon Bay is eutrophic (station 3; see map, page v). This lake ranked ninth in overall trophic quality when the 27 Utah lakes and reservoirs sampled in 1975 were compared using a combination of six parameters* (however, if the very high Widgeon Bay August chlorophyll a value of 55.6 µg/l is omitted, Fish Lake would rank fifth).

Ten of the water bodies had less median total phosphorus, none had less and ten had the same median inorganic nitrogen, five had less and two had the same median orthophosphorus, 20 had less mean chlorophyll a (eight omitting the 55.6 value), and none had greater mean Secchi disc transparency. No significant reduction of dissolved oxygen with depth occurred at any sampling station or time.

Survey limnologists did not observe surface concentrations of algae but noted sparse macrophytes in Widgeon Bay at station 3.

B. Rate-Limiting Nutrient:

Due to significant changes in nutrients in the samples during shipment to the laboratory, the algal assay results are not considered representative of conditions in the lake at the times the samples were collected. The lake data indicate nitrogen limitation both sampling times.

* See Appendix A.

C. Nutrient Controllability:

1. Point sources--No known municipal or industrial wastewater treatment plants impacted Fish Lake during the sampling year. Septic tanks serving lakeshore dwellings and recreational facilities contributed an estimated 8.1% of the total phosphorus load, but a shoreline survey is needed to determine the significance of those sources.

The present phosphorus loading of 0.05 g/m^2/year is less than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as an oligotrophic loading (see page 11). Because of the very long hydraulic retention time (58.5 years), phosphorus inputs should be minimized as much as possible to preserve the existing trophic quality of the main body of Fish Lake.

2. Non-point sources--Non-point sources, including direct precipitation, added 91.9% of the total phosphorus load to the lake during the sampling year. Jorgenson Creek contributed 24.2% of the total; Bowery Creek, 7.1%, Twin Creek, 3.0%; Doctor Creek, 2.0%; and the ungaged tributaries, an estimated 20.2%.

The phosphorus export rates of Jorgenson Creek, Bowery Creek, Twin Creek, and Doctor Creek were 14, 13, 12, and 1 kg/km^2/year, respectively (see page 10).

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 10.12 kilometers^2.
2. Mean depth: 25.9 meters.
3. Maximum depth: 53.3 meters.
4. Volume: 262.117 x 10^6 m^3.
5. Mean hydraulic retention time: 58.5 years.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Jorgenson Creek	8.3	0.056
Bowery Creek	2.6	0.018
Twin Creek	1.3	0.009
Doctor Creek	7.0	0.004
Minor tributaries & immediate drainage -	27.7	0.056
Totals	46.9	0.143

2. Outlet -

Lake Creek	57.0**	0.142

C. Precipitation***:

1. Year of sampling: 20.7 centimeters.
2. Mean annual: 20.7 centimeters.

---

† Table of metric conversions--Appendix B.
†† Ikner, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Fish Lake was sampled two times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from one or more depths at three stations on the lake (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during both visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 29.9 meters at station 1, 30.8 meters at station 2, and near-surface only at station 3.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR FISH LAKE
STORET CODE 4906

PARAMETER	1ST SAMPLING (8/12/75) 3 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (9/25/75) 3 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING 0 SITES RANGE	MEAN	MEDIAN
TEMP (C)	5.5 - 18.4	12.9	14.1	9.7 - 15.9	13.9	15.4	******	----------	
DISS OXY (MG/L)	4.6 - 10.2	8.0	8.0	5.4 - 10.8	8.3	8.6	******	----------	
CNDCTVY (MCROMO)	74. - 148.	95.	95.	73. - 125.	86.	85.	******	----------	
PH (STAND UNITS)	7.8 - 9.4	8.6	8.8	7.8 - 9.4	8.9	9.1	******	----------	
TOT ALK (MG/L)	61. - 78.	65.	64.	55. - 77.	62.	60.	******	----------	
TOT P (MG/L)	0.019 - 0.247	0.046	0.024	0.013 - 0.086	0.025	0.020	******	----------	
ORTHO P (MG/L)	0.002 - 0.017	0.006	0.004	0.002 - 0.013	0.005	0.004	******	----------	
NO2+NO3 (MG/L)	0.020 - 0.050	0.024	0.020	0.020 - 0.020	0.020	0.020	******	----------	
AMMONIA (MG/L)	0.020 - 0.050	0.022	0.020	0.020 - 0.030	0.021	0.020	******	----------	
KJEL N (MG/L)	0.400 - 3.600	0.714	0.450	0.400 - 1.200	0.515	0.400	******	----------	
INORG N (MG/L)	0.040 - 0.100	0.046	0.040	0.040 - 0.050	0.041	0.040	******	----------	
TOTAL N (MG/L)	0.420 - 3.630	0.739	0.470	0.420 - 1.220	0.535	0.420	******	----------	
CHLRPYL A (UG/L)	2.4 - 55.6	20.1	2.4	2.7 - 9.1	4.8	2.7	******	----------	
SECCHI (METERS)	15.2 - 15.2	15.2	15.2	6.1 - 15.2	10.6	10.6	******	----------	

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
08/12/75	1. Fragilaria sp.	2,281
	2. Microcystis sp.	2,082
	3. Chroococcus sp.	760
	4. Navicula sp.	198
	5. Dinobryon sp.	132
	Other genera	925
	Total	6,378
09/25/75	1. Chlamydomonas sp.	1,103
	2. Oocystis sp.	531
	3. Chroomonas (?) sp.	286
	4. Kirchneriella sp.	123
	5. Lagerheimia sp.	123
	Other genera	203
	Total	2,369

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
08/12/75	1	2.4
	2	2.4
	3	55.6
09/25/75	1	2.7
	2	9.1
	3	2.7

C. Limiting Nutrient Study:

The algal assay results are not considered representative of conditions in the lake because of significant changes in the sample nutrients from the time of collection to the time the assays were begun.

The lake data indicate nitrogen limitation both sampling times. The mean inorganic nitrogen to orthophosphorus ratios were 8 to 1 in August and in September, and nitrogen limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Utah National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v) when the sites were accessible. Sampling was begun in November, 1974, and was completed in October, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Utah District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Twin Creek at station D-1 and the mean annual ZZ flow.

No known wastewater treatment plants impacted Fish Lake during the sampling year.

A. Waste Sources:

1. Known municipal - None
2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (non-point load) -		
Jorgenson Creek	120	24.2
Bowery Creek	35	7.1
Twin Creek	15	3.0
Doctor Creek	10	2.0
b. Minor tributaries & immediate drainage (non-point load) -	100	20.2
c. Known municipal STP's - None	-	-
d. Septic tanks* -	40	8.1
e. Known industrial - None	-	-
f. Direct precipitation** -	175	35.4
Total	495	100.0

2. Outputs -

Lake outlet - Lake Creek 210

3. Net annual P accumulation - 285 kg.

* Estimate based on 5 campgrounds, 1 picnic area, and 100 dwellings; see Working Paper No. 175.

** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Jorgenson Creek	820	5.5
Bowery Creek	375	2.5
Twin Creek	180	1.2
Doctor Creek	75	0.5
b. Minor tributaries & immediate drainage (non-point load) -	1,115	7.5
c. Known municipal STP's -	None	-
d. Septic tanks* -	1,455	9.7
e. Known industrial -	None	-
f. Direct precipitation** -	10,925	73.1
Total	14,945	100.0

2. Outputs -

Lake outlet - Lake Creek 3,925

3. Net annual N accumulation - 11,020 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Jorgenson Creek	14	99
Bowery Creek	13	144
Twin Creek	12	138
Doctor Creek	1	11

* Estimate based on 5 campgrounds, 1 picnic area, and 100 dwellings; see Working Paper No. 175.

** See Working Paper No. 175.

E. Mean Nutrient Concentrations in Ungaged Stream:

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Anderson Creek	0.035	0.122

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.05	0.03	1.5	1.1

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Fish Lake:

"Dangerous" (eutrophic loading)	0.14
"Permissible" (oligotrophic loading)	0.07

V. LITERATURE REVIEWED

Ikner, James, 1975. Personal communication (lake morphometry). U.S. Geol. Surv., Salt Lake City.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
0408	LAKE POWELL	0.010	0.410	339.830	3.081	13.800	0.007
4901	BEAR LAKE	0.011	0.040	253.167	0.945	9.200	0.003
4902	LOWER BOWN'S RESERVOIR	0.031	0.040	336.000	5.567	9.400	0.006
4903	DEER CREEK RESERVOIR	0.038	0.215	430.333	9.078	14.800	0.006
4904	ECHO RESERVOIR	0.047	0.170	450.333	6.967	14.000	0.012
4905	LYNN RESERVOIR	0.121	0.200	417.667	39.600	10.400	0.052
4906	FISH LAKE	0.023	0.040	152.000	12.483	10.400	0.004
4907	HUNTINGTON NORTH RESERVO	0.013	0.040	392.000	1.900	7.800	0.005
4908	JOE'S VALLEY RESERVOIR	0.012	0.045	400.000	2.483	11.200	0.003
4909	MINERSVILLE RESERVOIR	0.192	0.060	445.000	33.583	8.600	0.107
4910	MOON LAKE	0.008	0.040	381.000	2.700	9.600	0.002
4911	NAVAJO LAKE	0.016	0.040	368.000	2.000	6.000	0.003
4912	NEWCASTLE RESERVOIR	0.051	0.040	428.667	12.467	13.600	0.009
4913	OTTER CREEK RESERVOIR	0.067	0.040	453.667	11.767	10.600	0.033
4914	PANGUITCH LAKE	0.071	0.040	426.500	45.950	14.200	0.010
4915	PELICAN LAKE	0.044	0.050	438.500	6.350	8.400	0.004
4916	PINEVIEW RESERVOIR	0.028	0.300	435.083	5.692	14.600	0.006
4917	PIUTE RESERVOIR	0.047	0.150	482.625	25.329	11.600	0.007
4918	PORCUPINE RESERVOIR	0.025	0.110	440.000	7.860	12.400	0.011
4919	PRUESS RESERVOIR (GARRIS	0.057	0.140	491.000	4.533	8.800	0.008
4920	SEVIER BRIDGE RESERVOIR	0.026	0.355	449.778	18.222	12.400	0.008
4921	STARVATION RESERVOIR	0.016	0.040	394.583	5.675	13.200	0.004
4922	STEINAKER RESERVOIR	0.011	0.040	316.750	1.844	12.600	0.005
4923	TROPIC RESERVOIR	0.021	0.050	425.000	7.200	8.400	0.006
4924	UTAH LAKE	0.132	0.320	490.583	72.012	11.400	0.012
4925	WILLARD BAY RESERVOIR	0.044	0.060	457.182	7.567	11.000	0.009
5605	FLAMING GORGE RESERVOIR	0.011	0.690	285.636	2.500	10.400	0.003

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
0408	LAKE POWELL	96 (25)	4 (1)	81 (21)	73 (19)	15 (4)	42 (11)	311
4901	BEAR LAKE	90 (23)	87 (19)	96 (25)	100 (26)	77 (20)	90 (23)	540
4902	LOWER BOWN'S RESERVOIR	46 (12)	87 (19)	85 (22)	65 (17)	73 (19)	50 (13)	406
4903	DEER CREEK RESERVOIR	42 (11)	19 (5)	42 (11)	35 (9)	0 (0)	58 (14)	196
4904	ECHO RESERVOIR	31 (8)	27 (7)	19 (5)	50 (13)	12 (3)	13 (3)	152
4905	LYNN RESERVOIR	8 (2)	23 (6)	58 (15)	8 (2)	62 (15)	4 (1)	163
4906	FISH LAKE	62 (16)	65 (16)	100 (26)	23 (6)	62 (15)	79 (20)	391
4907	HUNTINGTON NORTH RESERVO	77 (20)	65 (16)	69 (18)	92 (24)	96 (25)	69 (18)	468
4908	JOE'S VALLEY RESERVOIR	81 (21)	58 (15)	62 (16)	85 (22)	46 (12)	96 (25)	428
4909	MINERSVILLE RESERVOIR	0 (0)	44 (11)	27 (7)	12 (3)	85 (22)	0 (0)	168
4910	MOON LAKE	100 (26)	87 (19)	73 (19)	77 (20)	69 (18)	100 (26)	506
4911	NAVAJO LAKE	69 (18)	87 (19)	77 (20)	88 (23)	100 (26)	85 (22)	506
4912	NEWCASTLE RESERVOIR	23 (6)	87 (19)	46 (12)	27 (7)	19 (5)	27 (7)	229
4913	OTTER CREEK RESERVOIR	15 (4)	87 (19)	15 (4)	31 (8)	54 (14)	8 (2)	210
4914	PANGUITCH LAKE	12 (3)	65 (16)	50 (13)	4 (1)	8 (2)	23 (6)	162
4915	PELICAN LAKE	37 (9)	54 (14)	35 (9)	54 (14)	90 (23)	73 (19)	343
4916	PINEVIEW RESERVOIR	50 (13)	15 (4)	38 (10)	58 (15)	4 (1)	58 (14)	223
4917	PIUTE RESERVOIR	27 (7)	31 (8)	8 (2)	15 (4)	38 (10)	46 (12)	165
4918	PORCUPINE RESERVOIR	58 (15)	38 (10)	31 (8)	38 (10)	33 (8)	19 (5)	217
4919	PRUESS RESERVOIR (GARRIS	19 (5)	35 (9)	0 (0)	69 (18)	81 (21)	37 (9)	241
4920	SEVIER BRIDGE RESERVOIR	54 (14)	8 (2)	23 (6)	19 (5)	33 (8)	37 (9)	174
4921	STARVATION RESERVOIR	73 (19)	87 (19)	65 (17)	62 (16)	23 (6)	79 (20)	389
4922	STEINAKER RESERVOIR	85 (22)	87 (19)	88 (23)	96 (25)	27 (7)	65 (17)	448
4923	TROPIC RESERVOIR	65 (17)	50 (13)	54 (14)	46 (12)	90 (23)	58 (14)	363
4924	UTAH LAKE	4 (1)	12 (3)	4 (1)	0 (0)	42 (11)	13 (3)	75
4925	WILLARD BAY RESERVOIR	37 (9)	44 (11)	12 (3)	42 (11)	50 (13)	31 (8)	216
5605	FLAMING GORGE RESERVOIR	90 (23)	0 (0)	92 (24)	81 (21)	62 (15)	90 (23)	415

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4901	BEAR LAKE	540
2	4911	NAVAJO LAKE	506
3	4910	MOON LAKE	506
4	4907	HUNTINGTON NORTH RESERVO	468
5	4922	STEINAKER RESERVOIR	448
6	4903	JOE'S VALLEY RESERVOIR	428
7	5605	FLAMING GORGE RESERVOIR	415
8	4902	LOWER BOWN'S RESERVOIR	406
9	4906	FISH LAKE	391
10	4921	STARVATION RESERVOIR	389
11	4923	TROPIC RESERVOIR	363
12	4915	PELICAN LAKE	343
13	0408	LAKE POWELL	311
14	4919	PRUESS RESERVOIR (GARRIS	241
15	4912	NEWCASTLE RESERVOIR	229
16	4916	PINEVIEW RESERVOIR	223
17	4918	PORCUPINE RESERVOIR	217
18	4925	WILLARD BAY RESERVOIR	216
19	4913	OTTER CREEK RESERVOIR	210
20	4903	DEER CREEK RESERVOIR	196
21	4920	SEVIER BRIDGE RESERVOIR	174
22	4909	MINERSVILLE RESERVOIR	168
23	4917	PIUTE RESERVOIR	165
24	4905	LYNN RESERVOIR	163
25	4914	PANQUITCH LAKE	162
26	4904	ECHO RESERVOIR	152
27	4924	UTAH LAKE	75

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR UTAH 10/18/76

LAKE CODE 4906 FISH LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 57.0

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4906A1	57.0	0.057	0.057	0.057	0.113	0.170	0.227	0.425	0.255	0.085	0.085	0.085	0.085	0.142
490681	8.3	0.028	0.028	0.028	0.042	0.170	0.142	0.057	0.042	0.042	0.028	0.028	0.028	0.056
4906C1	2.6	0.008	0.008	0.008	0.014	0.054	0.045	0.017	0.014	0.011	0.011	0.008	0.008	0.018
4906D1	1.3	0.003	0.003	0.003	0.008	0.025	0.023	0.008	0.006	0.006	0.006	0.006	0.006	0.009
4906E1	7.0	0.003	0.003	0.003	0.003	0.011	0.011	0.003	0.003	0.003	0.003	0.003	0.003	0.004
4906ZZ	38.8	0.028	0.028	0.028	0.042	0.170	0.142	0.057	0.042	0.042	0.028	0.028	0.028	0.056

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 57.0
SUM OF SUB-DRAINAGE AREAS = 58.0

TOTAL FLOW IN = 1.69
TOTAL FLOW OUT = 1.70

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4906A1	11	74	0.142	9	0.085				
	12	74	0.142	14	0.113				
	1	75	0.142						
	2	75	0.142						
	3	75	0.113						
	4	75	0.113						
	5	75	0.255						
	6	75	0.340	15	0.396				
	7	75	0.566	3	0.595				
	8	75	0.311	17	0.227				
	9	75	0.113	6	0.113				
	10	75	0.028	5	0.003				
490681	11	74	0.057	9	0.028				
	12	74	0.057	14	0.042				
	1	75	0.057	11	0.057				
	2	75	0.057						
	3	75	0.042						
	4	75	0.042						
	5	75	0.113						
	6	75	0.255	15	0.311				
	7	75	0.113	3	0.113				
	8	75	0.057	18	0.042				
	9	75	0.042	9	0.057				
	10	75	0.042	5	0.028				

20

TRIBUTARY FLOW INFORMATION FOR UTAH 10/18/76

LAKE CODE 4906 FISH LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4906C1	11	74	0.017						
	12	74	0.017						
	1	75	0.017						
	2	75	0.017						
	3	75	0.014						
	4	75	0.014						
	5	75	0.031						
	6	75	0.085						
	7	75	0.034						
	8	75	0.017						
	9	75	0.014						
	10	75	0.017						
4906D1	11	74	0.008						
	12	74	0.008						
	1	75	0.008						
	2	75	0.008						
	3	75	0.008						
	4	75	0.008						
	5	75	0.017						
	6	75	0.042						
	7	75	0.017						
	8	75	0.008						
	9	75	0.006						
	10	75	0.008						
4906E1	11	74	0.008	9	0.006				
	12	74	0.008	14	0.008				
	1	75	0.003						
	2	75	0.003						
	3	75	0.003						
	4	75	0.003						
	5	75	0.008	18	0.008				
	6	75	0.008	15	0.008				
	7	75	0.006	3	0.006				
	8	75	0.003	18	0.003				
	9	75	0.006	6	0.006				
	10	75	0.006	5	0.006				
4906ZZ	11	74	0.057						
	12	74	0.057						
	1	75	0.057						
	2	75	0.057						
	3	75	0.042						
	4	75	0.042						
	5	75	0.113						
	6	75	0.283						
	7	75	0.113						
	8	75	0.057						
	9	75	0.042						
	10	75	0.057						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/08/12

490601
38 32 12.0 111 43 26.0 3
FISH LAKE
49041 UTAH

11EPALES 2111202
0095 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/08/12	16 30	0000	17.4	7.8	600	106	8.75	63	0.020K	0.400	0.020K	0.004
	16 30	0005	18.3	8.0		103	8.80	65	0.020K	0.400	0.020K	0.003
	16 30	0020	17.9	8.0		102	8.80	67	0.020K	0.600	0.020K	0.010
	16 30	0040	11.5	9.8		87	8.80	67	0.020K	0.500	0.020K	0.003
	16 30	0067	7.4	8.8		74	8.30	61	0.020K	0.500	0.020K	0.007
	16 30	0091	6.1	5.0		78	7.75	62	0.020	0.700	0.040	0.015
75/09/25	11 05	0000	15.8	8.2	240L	90	9.15	63	0.020K	0.400	0.020K	0.004
	11 05	0005	15.8.	8.6		87	9.10	58	0.020K	0.400	0.020K	0.003
	11 05	0020	15.7	8.6		85	9.20	60	0.020K	0.400	0.020K	0.005
	11 05	0045	14.7	10.8		83	8.90	55	0.020K	0.400	0.020K	0.003
	11 05	0060	11.2	7.2		73	7.90	59	0.020K	0.400	0.020K	0.008
	11 05	0098	9.8	5.4		73	9.10	60	0.020K	0.400	0.020K	0.004

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/08/12	16 30	0000	0.019	2.4	
	16 30	0005	0.022		
	16 30	0020	0.031		
	16 30	0040	0.024		
	16 30	0067	0.027		
	16 30	0091	0.088		
75/09/25	11 05	0000	0.022	2.7	
	11 05	0005	0.015		
	11 05	0020	0.015		
	11 05	0045	0.020		
	11 05	0060	0.024		
	11 05	0098	0.013		

K VALUE KNOWN TO BE
LESS THAN INDICATED

L ACTUAL VALUE IS KNOWN TO BE
GREATER THAN VALUE GIVEN

ATAD YTIRUCES DNA CHECKED BY USGS

STORET RETRIEVAL DATE 76/08/12

490602
38 33 16.0 111 42 28.0 3
FISH LAKE
49041 UTAH

11EPALES 2111202
0102 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/08/12	15 40	0000	17.8	7.8	600	106	8.90	64	0.020K	0.700	0.020K	0.005
	15 40	0005	17.2	7.8		102	8.80	63	0.020K	0.400	0.020K	0.003
	15 40	0025	16.7	7.6		103	8.80	65	0.020K	0.400	0.020K	0.003
	15 40	0035	10.8	10.2		86	8.80	66	0.020K	0.400	0.020K	0.003
	15 40	0050	8.7	9.6		80	8.65	64	0.020K	0.400	0.020K	0.002
	15 40	0075	6.5	8.2		75	8.10	64	0.020K	0.400	0.020K	0.005
	15 40	0098	5.5	4.6		78	7.75	64	0.050	0.600	0.050	0.009
75/09/25	11 30	0000	15.9	9.7	600	88	9.05	60	0.020K	0.400	0.020K	0.002
	11 30	0005	15.8	8.6		88	9.10	60	0.020K	0.400	0.020K	0.002
	11 30	0020	15.6	8.4		78	9.10	63	0.020K	0.400	0.020K	0.003
	11 30	0045	15.4	8.6		75	8.50	61	0.020K	0.400	0.020K	0.003
	11 30	0065	11.6	7.2		76	7.80	66	0.020K	0.600	0.020K	0.013
	11 30	0101	9.7	7.6		103	8.90	64	0.030	0.900	0.020K	0.013

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/08/12	15 40	0000	0.026	2.4	
	15 40	0005	0.020		
	15 40	0025	0.023		
	15 40	0035	0.024		
	15 40	0050	0.023		
	15 40	0075	0.025		
	15 40	0098	0.050		
75/09/25	11 30	0000	0.015	9.1	
	11 30	0005	0.014		
	11 30	0020	0.016		
	11 30	0045	0.023		
	11 30	0065	0.033		
	11 30	0101	0.086		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/12

490603
38 34 41.0 111 40 58.0 3
FISH LAKE
49041 UTAH

11EPALES 2111202
0002 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/08/12	15 30	0000	18.4	8.6		148	9.40	78	0.020	3.600	0.030	0.017
75/09/25	11 50	0000	14.3	8.6		125	9.45	77	0.020	1.200	0.020K	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/08/12	15 30	0000	0.247	55.6	
75/09/25	11 50	0000	0.028	2.7	

K VALUE KNOWN TO BE LESS THAN INDICATED

25

APPENDIX E

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/08/12

4906A1
38 35 36.0 111 40 27.0 4
LAKE CREEK
49 7.5 FISH LAKE
O/FISH LAKE
ORT RD BRDG 1.4 MI S OF FRYING PAN CMPGR
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/09	16	06	0.024	0.200	0.020	0.040	0.040
75/06/15	09	47	0.005	1.350	0.045	0.015	0.070
75/07/03	13	20	0.015	0.950	0.040	0.015	0.060
75/08/17	18	20	0.010	1.400	0.025	0.015	0.040
75/09/06	10	20	0.005	0.500	0.010	0.025	0.030
75/10/05	13	30	0.005	0.800	0.035	0.030	0.040

STORET RETRIEVAL DATE 76/08/12

490681
38 35 12.0 111 41 10.0 4
JORGENSON CREEK
49 7.5 FISH LAKE
T/FISH LAKE
HWY 25 BRDG 2 MI NE OF BOWERY CRK CMPGRD
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/09	15 55		0.112	0.200	0.020	0.070	0.070
74/12/14	10 05		0.144	0.400	0.045	0.060	0.080
75/06/15	09 30		0.045	0.725	0.020	0.055	0.070
75/07/03	13 15		0.140	0.050K	0.010	0.050	0.080
75/08/18	18 10		0.055	0.700	0.015	0.050	0.070
75/09/06	10 15		0.060	0.500	0.010	0.050	0.050
75/10/05	13 20		0.020	0.100K	0.010	0.045	0.050

K VALUE KNOWN TO BE
LESS THAN INDICATED

28

STORET RETRIEVAL DATE 76/08/12

4906C1
38 33 45.0 111 42 20.0 4
BOWERY CREEK
49 7.5 FISH LAKE
T/FISH LAKE
HWY 22 BRDG .1 MI S OF FISH HAVEN RESORT
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/09	15 43		0.056	0.300			
75/06/15	10 00		0.020	0.250	0.045	0.070	0.070
75/08/18	18 00		0.010	1.350	0.015	0.040	0.050
					0.010	0.025	0.060

STORET RETRIEVAL DATE 76/08/12

490601
38 32 55.0 111 43 25.0 4
TWIN CREEK
49 7.5 FISH LAKE
T/FISH LAKE
HWY 25 BRDG 1.1 M SW OF BOWERY CRK CMPGR
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/09	15	25	0.184	0.100	0.015	0.060	0.060
74/12/14	09	55	0.176	0.300	0.015	0.045	0.060
75/05/18	09	40	0.165	0.750	0.005K	0.050	0.050
75/06/15	09	35	0.155	0.400	0.020	0.050	0.060
75/07/03	12	35	0.025	1.050	0.020	0.055	0.070
75/08/18	18	00	0.170	0.850	0.025	0.045	0.050
75/09/06	10	05	0.155	0.100K	0.005K	0.047	0.047
75/10/05	13	00	0.165	0.300	0.010	0.045	0.060

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/12

4906E1
38 32 08.0 111 44 14.0 4
DOCTOR CANYON
49 7.5 FISH LAKE
T/FISH LAKE
HWY 25 BRDG 2.4 M SW OF BOWERY CRK CMPGR
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/09	15	15	0.192	0.200	0.020	0.060	0.060
74/12/14	09	45	0.184	0.300	0.020	0.040	0.060
75/05/18	09	00	0.185	0.950	0.020	0.060	0.085
75/06/15	08	30	0.100	0.150	0.025	0.050	0.070
75/07/03	12	30	0.045	0.150	0.035		0.050
75/08/18	17	50	0.055	1.050	0.017	0.025	0.040
75/09/06	10	00	0.075	0.500	0.075	0.030	0.060
75/10/05	13	00	0.115	0.600	0.012	0.035	0.060

STORET RETRIEVAL DATE 76/08/12

4906F1
38 33 00.0 111 43 30.0 4
ANDERSON CREEK
49041 FISH LAKE 7.5
T/FISH LAKE
HWY 25 .3MI S FISH LAKE RANGER STATION
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/09/06	10 05		0.020	0.100	0.015	0.030	0.030
75/10/05	13 05		0.025	0.100K	0.005K	0.030	0.040

K VALUE KNOWN TO BE
LESS THAN INDICATED